

STREAM AND WETLAND MONITORING PLAN

TULULA CREEK WETLAND MITIGATION SITE

The North Carolina Department of Transportation  
Raleigh, NC

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## 1.0 INTRODUCTION

The Tulula Creek Wetlands Mitigation Site is a 222 acre tract in Graham County, N.C. acquired and protected by the North Carolina Department of Transportation (NCDOT). The site is being developed as a NCDOT wetland and stream restoration project designed to assist in replacing highway-related impacts in the mountain region. The mitigation site contains regionally unique mountain bogs and floodplain wetlands, known as Tulula Bog, that have been heavily degraded by human activity.

The restoration work on Tulula Creek and the adjacent wetlands will be complete by the end of 2000 and NCDOT will begin monitoring the site. NCDOT has approved a grant for the University of North Carolina at Asheville (UNCA) to conduct research on the site that will provide us with monitoring data and information. Generally, the monitoring plan for the site follows the grant proposal submitted by UNCA. However, the grant also funds additional studies beyond monitoring regulatory success criteria. NCDOT will collect certain monitoring data not included in the grant proposal as discussed below.

The mitigation plan for Tulula Creek has been adjusted and modified by the Mitigation Review Team since it was written in 1997. However, much of the information in this document is derived from Sections 7.0 and 8.0 of the mitigation plan. A revised mitigation plan reflecting the changes will be distributed along with the As-Built Package once construction is complete.

## 2. SUMMARY OF UNCA RESEARCH GRANT

UNCA's research objectives are as follows: to determine the success of the stream realignment by evaluating the geomorphology of the new channel before and after water is introduced; to track restoration of site hydrology, evaluate changes in ecosystem structure and function associated with plant community succession in the floodplain in response to a higher water table and overbank flooding; to evaluate wildlife use of the site in response to changing hydrologic conditions (amphibians) and plant community succession (birds).

In addition to monitoring stream morphology, bank erosion will be determined using random 50 m segments. Groundwater wells will be installed throughout the site to observe changes in the water table.

Plant community succession studies will be supported by data collected on hydrology and soils in vegetation plots. UNCA will examine the effect of a post-restoration increase in the water table on woody and herbaceous plants in the open and closed canopy regions of the site. The grant proposal also includes monitoring the success of naturally-regenerating woody plants in previously converted fairways and a few designated areas within the floodplain. In order to observe bird response to plant succession, UNCA will conduct breeding bird surveys and collect habitat data during the spring and summers of 2000 and 2002.

UNCA will document the amphibian response to restored hydrology. Amphibians are the most important faunal element of these systems. Fish-free ponds created by NCDOT will be

monitored for amphibian reproduction, outbreaks of bacterial infections, and tracked to compare the colonization of ponds to pond size and location. UNCA has five years of baseline data to build upon. Wood frogs and spotted salamanders have been common at Tulula in the past and will be monitored during the increase in site hydrology. Also in the past five years UNCA biologists have witnessed catastrophic die-offs of amphibian larvae in ponds due to pathogenic bacteria. They will continue to investigate the outbreak of bacteria in the ponds and its effect on the amphibian population.

### 3.0 REGULATORY CRITERIA MONITORING PLAN

Monitoring of wetland and stream restoration efforts will be performed until success criteria are fulfilled according to the Army Corps of Engineer (CaE) guidelines. Monitoring is proposed for three wetland components, vegetation, hydrology, and stream morphology. Wetland soils currently exist within the mitigation area and monitoring soil conditions is not considered necessary to verify wetland and stream restoration success although will be monitored as part of UNCA's research.

#### 2.1 HYDROLOGY MONITORING

While hydrological modifications are being performed on the site, surficial monitoring wells will be designed and placed in accordance with specifications in U. S. Army Corps of Engineers', Installing Monitoring Wells/Piezometers in Wetlands (WRP Technical Note HY-IA- 3.1, August 1993). Monitoring wells will be set to a depth of 40 inches.

Approximately 30 continuously monitoring groundwater wells will be placed in eight transects perpendicular to the stream. The transects will be spaced out along the entire length of the newly constructed channel and extend into the adjacent wetlands of various ecosystem types. Ecosystem types support similar soils, landform, and target community structure. The groundwater wells will read daily and the data will be downloaded from each well once a month throughout the year.

A stream gauge that records stage (water surface) height will be placed in the primary' stream channel at the site outfall (Figure 3). Stream gauge data will be recorded at appropriate intervals (3-4 times a day) to determine the frequency of bankfull discharge based on the stream dimensions.

Geomorphology characteristics will be evaluated over time. The channel will be permanently staked at 50-m intervals and the sinuosity and the meander and riffle lengths will be determined for random 50-m segments. The permanent stakes will be used to collect data on cross-sectional channel characteristics. Additional discussion of hydrological monitoring can be found in the grant proposal.

In addition, NCDOT biologists conducted baseline benthic and fish sampling in the existing disturbed/channelized stream in the spring of 1998. Assuming that construction is

completed in the fall of 2000, they will return to survey the restored channel in the spring of 2001 and subsequent years during the monitoring period.

### 3.2 HYDROLOGY SUCCESS CRITERIA

Target hydrological characteristics include saturation or inundation for at least 12.5% of the growing season at lower landscape positions, during average climatic conditions. Upper landscape reaches may exhibit surface saturation/inundation between 5% and 12.5% of the growing season based on well data. These 5%-12.5% areas are expected to support hydrophytic vegetation. If wetland parameters are marginal as indicated by vegetation and hydrology monitoring, a jurisdictional determination will be performed in the questionable area. Comparisons can also be made to well data collected at some locations on the site prior to construction.

Stream gauge data will be utilized to substantiate the frequency of bankfull discharge. The target frequency of bankfull discharge is anticipated to exhibit a one to two year return interval under nonnal climatic conditions. Stream gauge monitoring and bankfull calculations will require average climatic conditions including an average distribution of peak stonn events.

### 3.3 VEGETATION MONITORING

Restoration monitoring procedures for vegetation are designed in accordance with EP A guidelines enumerated in Mitigation Site Type (MIST) documentation (EP A 1990) and CaE Compensatory Hardwood Mitigation Guidelines (DOA 1993). A general discussion of the restoration monitoring program is provided.

Phase I and II plantings include the former pine plantation, live staking, alder transplants, erosion control seeding, and tree planting in the areas disturbed by construction. After planting has been completed in winter or early spring, an initial evaluation will be performed to verify planting methods and to determine initial species composition and density. The upland buffers and protection areas will not be monitored. Supplemental planting and additional site modifications will be implemented, if necessary .

During the first year, vegetation will receive cursory, visual evaluation on aperiodic basis to ascertain the degree of overtopping of planted elements by nuisance species. Subsequently, quantitative sampling of vegetation will be performed between September 1 and October 30 after each growing season until the vegetation success criteria is achieved.

During quantitative vegetation sampling in early fall of the first year, approximately 15 sample lots will be randomly placed within each restored ecosystem type. Sample plot distributions will be correlated with hydrological monitoring locations to provide point-related data on hydrological and vegetation parameters. In each sample plot, vegetation parameters to be monitored include species composition and species density. Visual observations of the percent 90ver of shrub and herbaceous species will also be recorded. Vegetation monitoring is expanded beyond the regulatory success criteria by the UNCA grant proposal.

### 3.4 VEGETATION SUCCESS CRITERIA

Success criteria have been established to verify that the wetland vegetation component supports community elements necessary for a jurisdictional determination. Additional success criteria are dependent upon the density and growth of characteristic forest species. Specifically, a minimum mean density of 320 characteristic tree species must be surviving for 3 years after initial planting, and no species can comprise more than 20% of the 320 stem/acre total. The required survival criterion will decrease by 10% per year after the third year of vegetation monitoring (i.e., for an expected 290 stems per acre for year 4 and 260 stems per acre for year 5). Characteristic species include planted elements along with natural recruitment of tree species identified in reference ecosystems. Supplemental plantings will be performed as needed to achieve the vegetation success criteria.

No quantitative sampling requirements are proposed for herb assemblages as part of the vegetation success criteria. However, UNCA will be sampling for herb assemblages as part of the research grant proposal. Development of a swamp forest-bog complex over several decades and wetland hydrology will dictate the success of migration and establishment of desired wetland understory and groundcover populations. Visual estimates of the percent cover of herbaceous species and photographic evidence will be reported for information purposes.

#### CONTINGENCY

In the event that vegetation or hydrology success criteria are not fulfilled, a mechanism for contingency will be implemented. For vegetation contingency, replanting and extended monitoring periods will be implemented if community restoration does not fulfill minimum species density and distribution requirements. A few areas are being left unplanted to study natural regeneration and succession.

Hydrological and stream contingency will require consultation with hydrologists and regulatory agencies if wetland hydrology restoration is not achieved or stream destabilization occurs during the monitoring period. For stream destabilization, additional measures to induce revegetation of the site and channel represents the most likely contingency measure. Recommendations for contingency to establish wetland hydrology will be implemented and monitored until the Hydrology Success Criteria are achieved.

#### WETLAND FUNCTIONAL EVALUATIONS

Mitigation credit is typically determined based on wetland functions generated by restoration and comparison of restored functions to impacted wetland resources. An evaluation of mitigation wetlands is provided to orient crediting procedures as wetland impacts are quantified. This assessment subjectively evaluates mitigation wetland functions under existing conditions and compares these functions to the post restoration conditions. A brief summary of evaluations is provided.

Wetland functional evaluations entail subjective assessments of hydro geomorphic wetland functions outlined in various research and project literature (Brinson et al. 1995, ESI

1994b). This assessment categorizes functions into three primary areas: a) hydrodynamics; b) biogeochemical processes; and c) biotic resources.

Reference Forest Ecosystems (RFEs) were utilized as an indicator of wetland functions and wetland functional capacity. Target functions have been identified based on the types of potential wetlands present at Tulula Bog: forest gap-bogs, open bogs, seasonal inundated pools, and wet low terraces.

#### 4.1 WETLAND FUNCTIONS UNDER EXISTING CONDITIONS

The site consists of approximately 79 ha (196 ac) of mitigation land (wetlands and upland buffers) encompassing regionally unique bog and mountain floodplain wetlands that have been heavily degraded by human activity. An additional 11 ha (26 ac) of land exists in upland areas (protection zones) along eastern and western peripheries of the wetland complex. (90 ha [222 ac] total area).

During golf course construction, a linear dredged channel was constructed through the center of the floodplain and stream flows were diverted into the drainage network (Figure 3). The dredged channel (G stream type) within the E stream valley measures approximately 1814 m (5950 ft) in length. The upstream segment on the site contains approximately 427 m (1400 ft) of additional stream channel in a B valley. This B stream segment has sustained down-cutting (conversion to G) due to a migrating head-cut. Most of the historic E channel was buried under spoil or excavated to ditches that provide accelerated drainage to the dredged channel and off the site.

During this period, vegetation was cleared and spoil was systematically placed in proposed fairways, roads, and residential areas. Identified spoil mounds and ridges, covering approximately 4 ha (10 ac), have buried historic wetland surfaces in the floodplain. The sites support spoil ranging to approximately 1.2 m (4 ft) in thickness.

Dredging and straightening of waterways has lowered the groundwater table and induced channel grade degradation on the site and in the upper watershed. Feeder tributaries on adjacent terraces are apparently adapting to the induced (lowered) flow gradient by down-cutting into subsurface materials. Floodplains have been abandoned on the site and are most likely being abandoned along certain streams above the site. The lowering of groundwater and surface water flow gradients has caused mountain bog and seasonal pools to dry prematurely, jeopardizing the site's amphibian populations. As such, important wetland hydrodynamic functions have been lost including dynamic surface water storage, long-term surface water storage, and moderation of groundwater flow or discharge (Brinson *et al.* 1995).

The abandoned floodplain has been converted to an elevated terrace with negligible potential for future influence from overbank flooding or lateral stream migration. Studies indicate that under certain conditions, over 50% of a floodplain may be re-worked by stream shifts over a period of 70 years (Everitt 1968). Soil observations suggest a similar pattern of migration by Tulula Creek. This historic wetland attribute represents a critical factor in the

formation and maintenance of seasonal pools and regionally unique mountain bogs. Oxbows, discontinuous channels, feeder tributary braids, and alluvial fans appear to have modified most of the historic floodplain prior to dredging. Riverine wetland functions such as maintenance of characteristic habitat, energy dissipation, nutrient cycling, removal of imported elements and compounds, retention of particulates, and organic carbon export are considered lost.

The adjacent wetland terraces have sustained significant degradation due to down-cutting, ditching, spoil placement, and removal of vegetation. These systems contain an array of seeps, ephemeral streams, and permanent streams that appear to have degraded towards the induced downstream flow gradient. Minor floodplains (wetlands) along these terraces are also considered lost or disappearing due to disturbance. The largest terrace, situated in the northwestern portion of the property, has sustained further groundwater degradation due apparently to a large roadside ditch and white pine plantation along the old railroad bed (Figure 17).

Reduction or elimination of wetland hydrology and removal of forest vegetation throughout the site has also altered biogeochemical cycling and biological functions within the complex. The site may not support the hydroperiods required to maintain forest gap-bog communities, seasonal pools, seeps, or the wetland dependent wildlife regionally unique to the ecosystem. The site was previously classified as a swamp-bog complex prior to being partially converted into a golf course (Gaddy 1981, Schafale and Weakley 1990). Although the site still contained wetlands, it was no longer a functional swamp-bog complex prior to restoration work

#### 4.2 PROJECTED WETLAND FUNCTIONS UNDER POST-RESTORATION CONDITION

This restoration plan is designed to restore all the wetland features and functions similar to those exhibited by the reference wetlands. The wetlands and wetland buffers will be redirected towards historically stable conditions. After implementation, the site is expected to support approximately 41 ha (102 ac) within the wetland ecosystem, approximately 38 ha (95 ac) of upland buffers, and approximately 11 ha (26 ac) of surrounding upland parcels (upland protection zones). In addition, approximately 3366 m (11,040 ft) of reconstructed E stream and repaired B stream segments will flow through the wetland system.

Projected performance of wetland and stream functions is inferred from conditions expected 20 + years after mitigation activities are completed. This assessment assumes that restoration plans are implemented and that the stream and wetland is protected from man-induced disturbances in perpetuity. These assumptions are valid if the site is deeded or donated to a conservation organization that will manage the site after wetland restoration success is achieved.

Site alterations are expected to restore near-surface and above-surface hydrodynamics throughout the floodplain and wet terraces. Stream and groundwater flow gradients will be restored in both physiographic units. Mountain bogs, seasonal pools, and in-stream habitats characteristic of reference wetlands are expected to re-establish. All the hydrodynamic,

biogeochemical, and biotic functional attributes described in the preceding section will be restored, potentially returning the site to historic stream and wetland function.

Upland/wetland ecotones will also be restored within the wetland complex. Integration of wetland and upland interfaces are an important part of this mitigation plan. Upland buffer areas adjacent to the wetland complex offer an ecological gradient from uplands to wetlands and provide for ecotonal fringes. Without upland restoration/enhancement and upland buffer establishment, intrinsic functions in adjacent, restored wetlands may be diminished or lost in the future. These buffers will serve to diminish impacts from adjacent property developments, dumping, in-stream sedimentation, and noise associated with area highways. In addition, a number of biological and physical wetland parameters are also enhanced by the presence of wetland/upland ecotones on the mitigation site (Brinson *et al.* 1982, Cooper *et al.* 1986, Brown *et al.* 1990, Jurik *et al.* 1994, Karr and Schlosser 1978). Previous studies indicate that incorporation of wetland/upland ecotones may promote as much as a 20% increase in interior wetland functions (EST 1994b).

## Literature Cited

- Brinson, M., B. Swift, R. Platino, J. Barclay. 1981. Riparian Ecosystems: Their ecology and status. u.S. Fish and Wildlife Service FWS/OBS 81/17.
- Brinson, M.M., F.R. Hauer, L.C. Lee, R.P. Novitzki, W.L. Nutter, and D.F. Whingham. 1995. Guidebook for Application of Hydrogeomorphic Assessments to Riverine Wetlands. The National Wetlands Science Training Cooperative, Seattle, W A.
- Brown, M.T., J.M. Schaefer, K.H. Brandt. 1990. Buffer Zones for Water Wetlands, and Wildlife in East Centra Florida. Florida Agricultural Experiment Stations Journal Series No. T -00061. CFW publ. 89-07.
- Cooper, J.R., J.W. Gilliam, T.C. Jacobs. 1986. Riparian areas as control of non point pollutants. Pp. 166-192 in D.L. Correll (ed.), Watershed Research Perspectives. Smithsonian Institution Press. Washington D.C.
- Department of the Army (DOA). 1993 (unpublished). Corps of Engineers Wilmington District. Compensatory Hardwood Guidelines (12/8/93).
- Environmental Protection Agency (EPA). 1990. Mitigation Site Type Classification (MiST). EPA Workshop, August 13-15, 1989. EPA Region IV and Hardwood Research Cooperative, NCSU, Raleigh, North Carolina.
- Environmental Services, Inc. (ESI). 1994. Determination of Applicable Mitigation Credit for Upland Buffers: US 64 Wetland Restoration and Conservation Management Plan. Report prepared for the North Carolina Department of Transportation.



- Everitt, B.L. 1968. The Use of Cottonwood in the Investigation of the Recent History of a Floodplain. *American Journal of Science*. Vol. 206, pp. 417-39.
- Gaddy, L.L. 1981. The bogs of the southwestern mountains of North Carolina. Report to the North Carolina Natural Heritage Program.
- Jurik, T.W., S. Wang, A.G. van der Valko 1994. Effects of sediment loading on seedling emergence from wetland seed banks. *Wetlands* 14(3): 159-173, September 1994. The Society of Wetland Scientists.
- Karr, J.R., I.J. Schlosser. 1978. Water Resources at the land water interface. *Science*: 201: 229-234.
- Moorhead, K.K., I.M. Rossell, J. W. Petranka, C.R. Rossell. 2000. Ecological Assessment of a Wetlands Mitigation Bank. Research proposal to the Institute for Transportation Research and Education.
- North Carolina Department of Transportation (NCDOT). 1997. Stream and Wetland Mitigation Plan: Tulula Creek Wetlands Mitigation Bank, Graham County, North Carolina.
- Schafale, Michael P. and Alan S. Weakley. 1990. Classification of the Natural Communities of North Carolina: Third Approximation. North Carolina Natural Heritage Program, Division of Parks and Recreation, N.C. Department of Environment, Health, and Natural resources. Raleigh, North Carolina.
- Wetland Research Program. August 1993. Installing Monitoring Wells/ Piezometers in Wetlands, Technical Note HY-IA-3.1.